(54) Title: TYRE FOR MOTOR VEHICLES, WITH A WIDE TREAD, PARTICULARLY FOR SNOW-COVERED GROUND
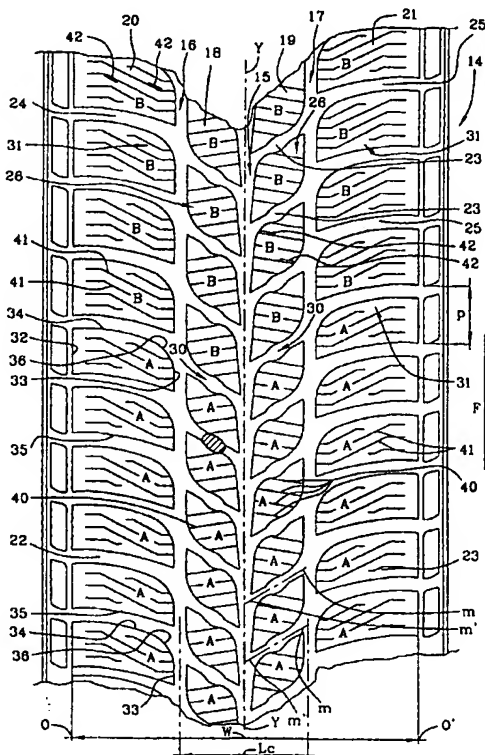
(57) Abstract: Winter tyre for vehicle wheels, provided with a tread comprising three circumferential grooves (15, 16, 17) and a plurality of transverse grooves (22, 23, 24, 25) which jointly delimit four circumferential rows of blocks, namely two axially outer shoulder rows (20, 21) and two centre rows (18, 19) at the sides of the equatorial plane. The transverse grooves converge on the equatorial plane in the direction of rolling specified for the tyre. In the tread, each transverse groove (22, 23) of the centre rows is made to comprise a widening of the cross section with an essentially circular profile, formed at a distance from the ends, for trapping snow. To obtain quieter running on dry roads, the front transverse edge profiles of the adjacent blocks of the centre rows are made to comprise at least two successive curvilinear portions. These curvilinear portions are shaped in different ways and with opposite curvatures to each other, to form means of attenuating the noise arising from the impact of the tread pattern on dry roads when the tyre is rolling.

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TYRE TREAD FOR MOTOR VEHICLES, PARTICULARLY FOR SNOW-COVERED GROUND

DESCRIPTION

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The present invention relates to tyres for motor vehicles, particularly for use on snow-covered ground.

As is known, a tyre in its most general form comprises a carcass structure, which includes a central
10 crown portion and two axially opposed side walls terminating in a pair of beads for securing the tyre to the rim of a wheel, a belt structure associated coaxially with the carcass structure and a tread extending coaxially around the belt structure.

15 The tread comprises a relief pattern, generally formed by a plurality of transverse and longitudinal grooves which, in combination, give rise to a plurality of blocks distributed in different types of configurations, for example along a central area
20 extending across the equatorial plane and in at least two shoulder areas extending in axially opposed positions on either side of the central area.

Of particular importance for the purposes of travel on a snow-covered surface is the presence, in
25 the blocks, of suitable sipes, in other words a closely spaced set of notches or grooves oriented essentially transversely with respect to the direction of rolling, and having small dimensions in the circumferential direction, the function of these being to collect and
30 retain the snow in an efficient way, since it has generally been shown to be convenient to exploit the friction of snow on snow.

One type of winter tyre marketed by the applicant has, in the tread, a pair of rectilinear
35 circumferential grooves, arranged symmetrically with respect to the equatorial plane of the tyre and spaced apart by a distance essentially equal to half of the total width of the tread.

These circumferential grooves are combined with two sets of transverse grooves, each of which extends with a progressively increasing inclination from the outer edge of the tread to a point on the equatorial

5   plane. The transverse grooves of the two sets converge symmetrically about the equatorial plane of the tyre in a predetermined preferred direction of rolling, and have their vertices interleaved with each other alternately along the perimetric extension of the tread

10 on the equatorial plane.

In this tread, the configuration of the transverse grooves is such as to promote good characteristics of traction because of the mutual convergence of the grooves in the direction of rolling.

15 The circumferential rectilinear grooves, in turn, enable water to be removed efficiently from the footprint during travel on a wet surface, thus impeding the occurrence of the well-known and dangerous effect of aquaplaning.

20 The traction and the overall behaviour in travel on a snow-covered surface are improved by the provision of closely spaced sipes on the blocks generated by the intersection of the longitudinal grooves with the transverse ones and by suitable rectilinear recesses,

25 associated with the transverse grooves, in the space delimited by the two circumferential grooves, each of the said rectilinear recesses extending in the circumferential direction for a short distance from the corresponding transverse groove.

30 Patent EP-773,116 held by the present applicant also discloses a tyre for snow-covered surfaces, provided with a tread band in which the circumferential grooves are formed by a sequence of portions oriented obliquely with respect to the circumferential direction

35 of the tyre; these oblique portions converge symmetrically on the equatorial plane but in the opposite direction to the direction of convergence of the transverse grooves.

Each of the oblique portions of the circumferential grooves extends between two consecutive transverse grooves and delimits the opposing circumferential edges of a centre block in one case and a shoulder block in the other case.

In this solution, each of the centre and shoulder blocks has a corner projecting into the corresponding circumferential groove with respect to the opposite corner of the block immediately following it.

In this situation, the projecting corners of the centre blocks act as teeth which provide grip on snow in traction, while the projecting corners of the shoulder blocks produce this effect during braking.

In order to increase the grip on snow, this tyre also has a recess of trapezoidal shape extending partially between two adjacent blocks in the same centre row.

This recess passes through the transverse groove between the two centre blocks and has an inner circumferential edge and an outer circumferential edge which diverge from each other at angles preferably within the range from 3° to 15°, in the opposite direction to the direction of rolling.

However, the pattern of a tread suitable for gripping on snow, being of the block type, causes a certain degree of noise on dry roads because of the successive impacts of the transverse sides of the blocks on the ground.

In considering the cited prior art, the applicant has perceived the necessity of providing a tyre for snow-covered ground which can simultaneously ensure a good grip on snow-covered ground, quiet running characteristics on dry roads, and a high wear resistance of the tread blocks.

The applicant has found that these advantages can be achieved by providing facing transverse edge profiles of the circumferentially adjacent blocks which are such as to produce, when combined in pairs, means

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of gripping the snow with a corrugated profile, together with variations of their profile which are such as to attenuate the impact of the block on the ground in conditions of rolling on dry roads.

5   A first aspect of the invention is therefore a winter tyre for vehicle wheels, comprising a carcass structure which includes a central crown portion and two axially opposed side walls; a belt structure associated coaxially with the carcass structure; and a

10   tread extending coaxially around the belt structure, impressed with a relief pattern which comprises at least one row of blocks delimited by a pair of circumferential grooves intersected by transverse grooves.

15   Each block is essentially delimited by two longitudinal sides in the circumferential direction and by two transverse sides, or transverse edge profiles, one at the front and one at the rear with respect to a predetermined direction of rolling.

20   The principal characteristics of the said tread are as follows:

a)   each transverse groove comprises an enlargement of the cross section having an essentially curvilinear profile; this enlargement of the cross

25   section is formed in the central area of each transverse groove and is designed to trap snow;

b)   each of the transverse edge profiles of the blocks comprises at least two successive curvilinear portions shaped differently from each other, to

30   form means of attenuating the noise generated by the contact of the tread with dry roads when the tyre is rolling.

In a preferred embodiment, all the blocks of the said at least one row are identical to each other.

35   Preferably, the transverse edge of a block comprises two curvilinear portions arranged in a sequence which is the reverse of that of the facing

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transverse edge profile of a circumferentially adjacent block.

In a further embodiment, each of the transverse edge profiles of the blocks comprises a first rectilinear portion followed by two curvilinear portions.

Additionally, the two curvilinear portions are preferably formed by a first curvilinear portion which is concave towards the inside of the block and a second curvilinear portion with a curvature opposite that of the first portion.

In particular, the tyre according to the invention is characterized in that the said first curvilinear portion following the said rectilinear portion comprises two circular arcs, namely a first and a second circular arc, and the said second curvilinear portion comprises a third circular arc, the radius of the first circular arc being equal to or greater than the radius of the second and the third circular arc, and the radius of the third circular arc being equal to or greater than the radius of the second circular arc.

Preferably, the ratio between the radii of the first and the second circular arc is in the range from 1 to 6.

Additionally, the ratio between the radii of the third and the second circular arc is preferably in the range from 1 to 4.

Preferably, the second and the third circular arc are linked together by a further fourth circular arc having a radius not greater than the radius of any of the adjacent circular arcs.

In a preferred embodiment, the blocks are essentially rhomboid in shape, with a major diagonal converging on the equatorial plane at an angle in the range from 25° to 55°, and preferably not greater than 45°.

More particularly, each block is essentially in the shape of an irregular rhombus which approximates to

the pointed ovoid shape of the leaves of certain plants. In one embodiment according to the invention, the tread comprises a first and a second centre row of blocks having the shape described above.

5   In this solution, the first centre row is located between a first circumferential groove lying in the equatorial plane and a second circumferential groove in a lateral position, while the second centre row is located between the said first circumferential groove

10   and a third circumferential groove in an axially opposing lateral position; the blocks are separated from each other by transverse grooves having mid-line axes inclined with respect to the equatorial plane.

        Preferably, the blocks of the two centre rows are

15   staggered circumferentially with respect to each other.

        In a further solution, the mid-line axes of the transverse grooves of the two centre rows are inclined in opposite directions from each other with respect to the equatorial plane.

20   In a further preferred embodiment, the tyre comprises two rows of shoulder blocks at the sides of the centre rows.

        A first row of shoulder blocks is positioned between the second circumferential groove and a first

25   edge of the tread, while the second shoulder row is positioned between the third circumferential groove and the opposite edge of the tread; the blocks of each shoulder row are separated from each other circumferentially by transverse grooves.

30   Preferably, each of the blocks of the shoulder rows has its shape delimited by longitudinal sides parallel to the equatorial plane, by transverse sides and by a curvilinear linking profile between the axially inner longitudinal side and the rear transverse

35   side. Preferably, the said transverse sides have a curvilinear shape.

Preferably, the centre and shoulder blocks have curvilinear linking portions which are opposite each other along the lateral circumferential grooves.

Advantageously, the said curvilinear linking portions which are opposite each other form a widening of the circumferential groove intended to trap snow.

Preferably, the centre and shoulder blocks comprise a plurality of sipes oriented parallel to each other within each block.

Even more preferably, in each row of blocks the sipes of each block are oriented in directions different from the direction of the transverse grooves.

It has been found that this difference between the orientation of the directions of the sipes and the transverse grooves improves traction on snow and does not adversely affect the quiet running of the tyre on dry roads.

Further characteristics and advantages will be made clearer by the following description of an example of a preferred embodiment of a tyre according to the invention, provided for guidance and without restrictive intent, with reference to the attached drawings, in which:

Figure 1 shows a partial cross-sectional view of a tyre according to the invention;

Figure 2 shows a partial development, in plan view, of the tread of the tyre of Figure 1;

Figure 3 shows an enlargement of a portion of Figure 2;

Figure 4 shows some details of a portion of a block illustrated in Figure 3;

Figure 5 shows an enlargement of some parts of Figure 2;

Figure 6 shows a comparison between the transverse edge profile of a block according to the invention and that of a known block;

Figure 7 shows a variant of the pattern of the tread of Figure 2.

With reference to Figure 1, the number 1 indicates
in a general way a tyre for motor vehicles according to
the invention, for example a tyre of the 195/65 R 15
grade.

5   The tyre 1 comprises a carcass structure 2,
including a central crown portion 3 and two side walls
4, 5, the said carcass structure 2 being provided with
a reinforcing ply 2a whose opposite ends 2b, 2c are
associated with corresponding bead wires 6, 7 located
10   at the radially inner sides of the said side walls 4,
5. In the illustrated case, the ends of the ply are
wound around the said bead wires, and in this case an
elastomeric filler 8 is applied to the radially outer
perimetric edges of the bead wires 6, 7, to occupy the
15   space formed between the reinforcing ply 2a and the
corresponding ends 2b, 2c of the reinforcing ply 2a.

As is known, the opposing areas of the tyre 1,
each comprising a bead wire 6, 7 and the filler 8, form
what are known as beads, indicated as a whole by 9 and
20   10, intended to secure the tyre 1 on a corresponding
mounting rim 11 of the wheel of a vehicle.

A belt structure 12, comprising one or more
reinforcing plies 13 made from textile or metal cords
incorporated in a specified mixture, is associated
25   coaxially with the aforesaid carcass structure 2.

A tread 14, in the thickness of which a pattern
shown in more detail in Figure 2 is cut, is applied in
a known way to the belt structure 12.

The tread according to the invention is
30   particularly suitable for snow-covered surfaces.

The tread 14 comprises three circumferential
grooves, namely one groove (15) located in the central
position, along the equatorial plane, and two lateral
grooves 16, 17. The intersection between the said
35   circumferential grooves and a plurality of transverse
grooves 22, 23, 24, 25 delimits four circumferential
rows of blocks, namely two centre rows 18, 19 lying
across the equatorial plane and two shoulder rows 20,

21 located on opposite sides of the centre row of blocks.

The transverse grooves 22, 23 delimiting the blocks of the centre rows 18, 19 have, for each row,
mid-lines m-m inclined at equal angles to the equatorial plane, and the grooves of the two rows converge on the equatorial plane in the direction of rolling shown by the arrow F in Figure 2.

These transverse grooves of the centre rows intersect the lateral circumferential grooves 16, 17 and continue to form the transverse grooves 24, 25 of the shoulder rows 20, 21.

The circumferential grooves 15, 16, 17 have mid-line axes essentially parallel to the equatorial plane: preferably these grooves have a depth in the range from 4 to 12 mm.

The width of the lateral circumferential grooves 16, 17 is preferably in the range from 2 to 10 mm, more preferably from 4 to 8 mm; the width of the central circumferential groove 15 between the blocks of the two centre rows is preferably in the range from 2 to 8 mm, and preferably from 4 to 6 mm.

It is specified at this point that the term "width" denotes the opening of the groove, in other words the axial distance between the straight lines tangent to the inner edges of the groove.

The transverse grooves 22, 23 preferably have a depth in the range from 4 to 10 mm. Preferably they have a maximum width in the range from 2 to 5 mm.

The transverse grooves 24, 25 preferably have a depth in the range from 4 to 10 mm. Preferably they have a maximum width in the range from 4 to 9 mm.

Preferably, both the transverse grooves and the circumferential grooves have an equal depth, for example a depth of 8 mm in the tyre considered here.

In the following text, for the sake of simplicity, only the part of the tread 14 of Figure 2 located to the left of the equatorial plane Y-Y will be described

in detail, since the part located to the right of the said plane is identical to the left-hand part rotated through 180° about the equatorial plane and shifted by a predetermined amount in the circumferential direction.

5　　　The blocks will now be described; it should be noted that each block comprises two longitudinal sides and two transverse sides, called the front and rear sides according to the direction of travel.

　　　The blocks 26 of the centre rows 18, 19 are
10　inscribed in a regular parallelogram formed by longitudinal sides which are essentially parallel to the equatorial plane and by transverse sides which are inclined at equal angles to the equatorial plane, although they depart from this profile in the way
15　described below.

　　　Preferably, the axially inner longitudinal sides are spaced apart from the equatorial plane by a distance equal to half of the width of the said central groove.

20　　　More precisely, as shown clearly in Figure 3, the block 26 of the centre row departs from the shape of a regular parallelogram delimited by longitudinal sides "a" and "b", transverse sides "c" and "d" and diagonals I_2 and I_1 in the following ways::

25　● the axially outer longitudinal side of the block is aligned with the outer side "a" of the parallelogram and its length is shorter than this side of the parallelogram, being preferably not more than 75% of the length "a";

30　● the axially inner longitudinal side is inclined at an angle α, in the range from 5° to 18°, to the equatorial plane;

　　　● the transverse sides have a portion of predetermined length, preferably not exceeding 35% of "c", in
35　　common with the corresponding sides "c" and "d" of the parallelogram;

　　　● the maximum linear extension of the block coincides with the longer diagonal I_1 of the parallelogram; this

diagonal is inclined with respect to the equatorial plane at an angle δ, preferably in the range from 25° to 55°;

- the maximum transverse dimension is smaller than the length of the smaller diagonal l_2 of the parallelogram and is preferably not greater than 75% of l_2;
- the overall shape is a pointed ovoid shape enclosed in a parallelogram in which the ratio l_2/l_1 between the minor diagonal and the major diagonal is preferably in the range from 0.50 to 0.70.

It should be noted that the transverse sides of the centre blocks are of a special design, in that each of them is formed by a profile comprising at least three portions, all shaped differently from each other.

As shown clearly by the enlargement in Figure 4, the transverse edge profile "c" of the centre block 26 comprises a first rectilinear portion 27 and two successive curvilinear portions 28, 29, of which one is concave and the other is convex towards the outside of the block.

The first rectilinear portion 27 is inclined with respect to the diagonal l_1 at an angle β in the range from 20° to 35°.

In a first embodiment, these successive curvilinear portions are parabolic arcs.

In a different embodiment, both the first and the second curvilinear arc are shaped in the form of circular arcs.

More precisely, the first curvilinear portion 28 comprises two circular arcs, namely a first and a second, having radii of r_1 and r_2 respectively, and the second curvilinear portion 29 comprises a third circular arc having a radius r_3.

Preferably, the first and the second curvilinear portions are linked together by a fourth circular arc having a radius r_4.

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Preferably, the configuration of the transverse edge profile of the block 26 has the following additional characteristics:

- the ratio between the radius r_1 of the first and the
5 radius r_2 of the second circular arc is in the range from 1 to 6;

- the ratio between the radius r_3 of the third and the radius r_2 of the second circular arc is in the range from 1 to 4;

10 - the link radius r_4 is smaller than any of the other radii;

- the distance "D" between the first rectilinear portion and the parallel line tangent to the second circular arc at the point R of maximum extension of
15 the cavity formed by the said curvilinear portion 28, measured perpendicularly to the said rectilinear portion, is in the range from 1 to 3 mm.

If we now go on to examine Figure 2 in combination with Figure 3, it will be noted that the three
20 different portions 27, 28, 29 of a transverse edge profile of a given block 26 have a sequence which is the inverse of that of the facing transverse edge profile of an adjacent block of the same row; this characteristic enables a widening of the cross section
25 30 to be formed in each transverse groove 22, 23. This widening has a curvilinear shape, preferably of the circular type, in an area essentially equidistant from the ends of the transverse groove 22, 23.

It has been found that the curvilinear shape of
30 the widening of the cross section 30 advantageously maintains a sufficient resistance of the elastomeric material to tearing and abrasion (wear) in the block.

Additionally, this widening of cross section 30 advantageously forms a gripping means which is
35 particularly suitable for trapping snow, as shown by the hatching in Figure 2.

Preferably, these widenings of the cross section are all of the same size.

If we now go on to examine the characteristics of the blocks of the lateral rows, it will be noted that these can have various shapes which are different from those described above.

5 The block shape which is most convenient for the purposes of the invention is that shown in Figure 2. In greater detail, each block 31 of the shoulder rows 20, 21 is delimited by longitudinal sides 32, 33 which are essentially parallel to the equatorial plane, by

10 transverse sides 34, 35 with a curvilinear form and by a curvilinear linking profile 36 between the axially inner longitudinal side and one of the transverse sides. Preferably, the said curvilinear profile 36 is a circular arc.

15 In the example in Figure 2, the curvilinear profile 36 forms a link between the longitudinal side 33 and the transverse side which is at the rear with respect to the direction of advance of the tyre.

The shoulder blocks 31 follow each other

20 circumferentially with a predetermined interval "p" which is preferably in the range from 20 mm to 40 mm.

Additionally, the centre blocks 26 and the adjacent shoulder blocks 31 are staggered circumferentially with respect to each other by a

25 distance preferably equal to approximately 50% of the mean interval. Preferably, as seen in the enlargement of Figure 5, this staggering is carried out in such a way that the curvilinear link 36 between one side and one longitudinal side of the shoulder block 31 is

30 opposite the curvilinear link 36' between one longitudinal side and one transverse side of the centre block 26.

In Figure 5, "T" indicates the distance between the said curvilinear links 36, 36'.

35 In practice, the centre and shoulder blocks are designed with curvilinear links which make their shapes depart from those of blocks in the form of acute-angled rhombuses.

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Essentially, the aforesaid links remove from the blocks 26, 31 the quantity of · elastomeric material corresponding to the areas 37, 38 shown by hatching in Figure 5.

5   Advantageously, this design and arrangement of the blocks provides a localized widening of the lateral circumferential groove 16, 17 and, therefore, a more suitable grip of the snow, as shown schematically by hatching in the area 39 of Figure 5.

10   In order to optimize the grip of the tread on snow-covered ground, each of the centre and shoulder blocks is provided with a plurality of incisions, known to those skilled in the art as "sipes".

Preferably, the sipes within the blocks of each
15   row are parallel to each other, with an orientation different from the direction of the transverse grooves of the same row; preferably, this orientation is in the opposite direction, with respect to the equatorial plane, to that of the said transverse grooves.

20   It has been found that this arrangement improves the grip on snow without adversely affecting the quiet running of the tyre on dry roads.

In greater detail, the centre blocks 26 comprise sets of sipes 40, parallel to each other in each block,
25   inclined in the opposite direction to the transverse grooves 22, 23 with respect to the equatorial plane, at an angle γ preferably in the range from 0° to 30° with respect to the axial direction.

In turn, each of the shoulder blocks 31 preferably
30   comprises a plurality of sipes 41, each comprising three successive portions shaped in the form of a three-part broken line with the central portion inclined with respect to the equatorial plane, and having a direction opposite that of the sipes 40 of the
35   blocks of the adjacent centre row; the angle of inclination of the said central portions of the sipes 41 with respect to the equatorial plane is preferably

in the range from 0° to 45° with respect to the axis of rotation.

In order to reduce noise, the sipes of the centre and shoulder blocks on the same side of the equatorial
5   plane are inclined in the opposite direction (Fig. 2) to those of the blocks of the corresponding rows located on the other side of the equatorial plane.

Also in order to optimize the grip of the tread on snow-covered roads, the shoulder and centre blocks can
10   also comprise notches 42 (Fig. 7) located along the axially outer longitudinal sides of the shoulder blocks.

Preferably, the said notches are located on extensions of the adjacent portions adjacent of
15   corresponding sipes or are parallel to them.

These notches are preferably deeper and a wider than the said sipes; in an example of embodiment, the notches 42 have a width and a depth of 2 mm and the ratio between the depth of the notches and that of the
20   sipes is preferably in the range from 0.20 to 0.60. In the previously mentioned tyre, this value is 0.25.

The tyre according to the invention has made it possible to decrease the running noise on dry roads.

It is considered that one of the factors which may
25   have contributed to the achievement of quieter running may be the particular profile of the transverse sides of the centre blocks.

To provide a better understanding of the possible improvements in quietness, Figure 6 shows the
30   transverse edge profile of a conventional block with a rectilinear profile N and that of a block according to the invention, in the condition in which successive points of these profiles touch the ground during the progressive advance of the tyre in the direction of
35   rolling F.

The progressive advance of the tyre on the ground is represented by the lines 1-8, all at equal distances from each other.

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As can be seen, the block having a rectilinear transverse edge profile comes into contact with the ground via consecutive portions of identical shape and length; therefore, portions of the front profile of the
5 block strike the ground in succession at a single specific frequency which forms a source of noise.

It may be noted that, in the tyre according to the invention, the contact with the ground initially involves portions of identical shape and length, such
10 as AB, BC, followed by a portion CD which differs in both shape and length from the preceding portions, then by a portion DE which is different from and longer than the preceding ones, then by a portion EF with a configuration and linear dimension which is even
15 greater than the preceding ones, and in any case has a completely different profile, and finally by a portion FG which is different from and shorter than the preceding one.

Essentially, it can be asserted that the impact of
20 the transverse edge profile of the block according to the invention does not give rise to a repetitive phenomenon such as that found in the case of a rectilinear transverse edge profile N.

It is likely that this characteristic is
25 responsible for the quieter running which has been found.

A further advantage of the invention is provided by one of the preferred embodiments in which the tread pattern of Figure 2 is combined with a predetermined
30 axial width of the centre and shoulder rows of the tread pattern.

If W indicates (Fig. 2) the total axial width of the tread between the shoulder separating recesses O, O' of the tyre, it is convenient to make the axial
35 width L_c of the centre rows smaller than that of the shoulder rows.

Preferably, the ratio L_c/W does not exceed 0.45.

If the portion of tread containing the centre rows is made with the aforesaid axial width L_c, the longitudinal hinges represented by the lateral circumferential grooves 16, 17 are shifted towards the
5   equatorial plane (Figure 2).

With this solution, it has been found possible to improve simultaneously both the traction on snow and the behaviour of the tyre, as well as its quietness on dry roads, without degrading the resistance to wear.

10   It should be noted that the invention comprises further alternative embodiments in addition to those described above.

To give a clearer picture of the possible embodiments of the invention, reference will now be
15   made to the tread illustrated in Figure 7, in which the same reference numbers indicate identical elements which have already been described in the preceding figures.

Moving on to a more detailed examination, it will
20   be noted that the variant illustrated in Figure 7 differs from that illustrated in Figure 2 in the following characteristics:

• the mid-line axes of the transverse grooves of the two centre rows 18, 19 are inclined in the same
25   direction with respect to the equatorial plane;

• the sipes 40 of the blocks 26 of the two centre rows run in the same direction with respect to the equatorial plane;

• the blocks of one shoulder row 20, when rotated
30   through 180° about the axial direction, match the blocks of the second shoulder row 21.

According to a previously described embodiment, the variant in Figure 7 shows a plurality of notches 42 which help to trap snow at the end of each shoulder
35   block.

These notches are distributed in an essentially uniform way, with an orientation which in some

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solutions, such as that of Figure 7, can lie perpendicularly to the equatorial plane.

In further embodiments, which can be easily derived from the above description and are therefore
5   not illustrated, the tread can comprise two further intermediate rows of blocks, preferably also of pointed ovoid shape, located between the two central rows and the two lateral rows shown in Figure 2.

In other words, the design and arrangement of the
10   blocks of the intermediate rows can again be such that the aforesaid localized widening of the transverse grooves and/or the circumferential grooves is produced, thus providing a better grip on snow, the whole being as shown schematically by the hatched areas in Figure
15   5.

It should be noted, however, that the blocks of the intermediate rows could have configurations different from those of the blocks of the centre rows, or could have polygonal profiles different from those
20   described.

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CLAIMS

1.   Tyre for vehicle wheels, comprising: a carcass structure, which includes a central crown portion and two axially opposed side walls; a belt structure associated coaxially with the carcass structure; a tread extending coaxially around the belt structure, impressed with a relief pattern which comprises at least one row of blocks separated by transverse grooves intersecting two circumferential grooves, each block being delimited essentially by two longitudinal sides in the circumferential direction and by two transverse sides, namely a front and a rear side with respect to a predetermined direction of rolling, characterized in that:

a)   each transverse groove comprises a widening of cross section with an essentially curvilinear profile, the said widening being provided in an area essentially equidistant from the ends of each transverse groove;

b)   the transverse sides of circumferentially adjacent blocks comprise at least two successive curvilinear portions shaped differently from each other, to form means of attenuating the noise when the tyre is rolling.

2.   Tyre according to Claim 1, characterized in that the transverse edge profile of a block comprises two curvilinear portions arranged in a succession which is the inverse of that of the facing transverse edge profile of an adjacent block.

3.   Tyre according to Claim 1, characterized in that the transverse edge profile of each block comprises a first rectilinear portion followed by the said two curvilinear portions.

4.   Tyre according to Claim 3, characterized in that the said two curvilinear portions are formed by a first curvilinear portion which is concave towards the inside of the block and a second curvilinear portion with a curvature opposite that of the first portion.

5.   Tyre according to Claim 4, characterized in that the said first curvilinear portion following the said rectilinear portion comprises two circular arcs, namely a first and a second arc, and the said second

5   curvilinear portion comprises a third circular arc, the radius of the first circular arc being greater than the radius of the second and of the third circular arc, and the radius of the third circular arc being greater than the radius of the second circular arc.

10   6.   Tyre according to Claim 4, characterized in that the distance between the said rectilinear portion and a parallel line tangent to the second circular arc at the point of maximum extension of the concavity formed by the said first curvilinear portion, measured

15   perpendicularly to the said rectilinear portion, is in the range from 1 to 3 mm.

7.   Tyre according to Claim 5, characterized in that the ratio between the radii of the first and the second circular arc is in the range from 1 to 6.

20   8.   Tyre according to Claim 5, characterized in that the ratio between the radii of the third and the second circular arc is in the range from 1 to 4.

9.   Tyre according to Claim 5, characterized in that the second and the third circular arc are linked

25   together by a further fourth circular arc having a radius not greater than the radius of any of the adjacent circular arcs.

10.   Tyre according to Claim 3, characterized in that the rectilinear portion of each transverse edge profile

30   of the centre blocks is inclined at an angle in the range from 20° to 35° to the diagonal of the rhombus which contains it.

11.   Tyre according to Claim 1, characterized in that the axially outer longitudinal sides of each centre

35   block are parallel to the equatorial plane.

12.   Tyre according to Claim 1, characterized in that the axially inner longitudinal sides of the centre

blocks form angles in the range from 5° to 18° with the direction of the equatorial plane.

13. Tyre according to Claim 1, characterized in that the said at least one row of blocks is contained in a
5   row of parallelograms in which:
• the axially inner longitudinal sides of the parallelograms are parallel to the equatorial plane and equidistant from the said plane;
• the axially outer longitudinal sides of the
10 parallelograms are parallel to the equatorial plane and partially coincide with the longitudinal sides of the blocks;
• the transverse sides of the parallelograms are parallel to each other, converge on the equatorial
15 plane and partially coincide with the transverse edge profiles of the blocks;
• the transverse sides of the parallelograms on one side of the equatorial plane are staggered circumferentially with respect to those arranged on the
20 other side by a distance essentially equal to half of their circumferential interval.

14. Tyre according to Claim 13, characterized in that the ratio between the minor diagonal and the major diagonal of each of the said parallelograms is in the
·25 range from 0.50 to 0.70.

15. Tyre according to Claim 1, characterized in that the said blocks are essentially rhomboid in shape, with the major diagonal converging on the equatorial plane at an angle in the range from 25° to 55°.

30 16. Tyre according to Claim 1, characterized in that it comprises a first and a second centre row of said blocks, the first row being located between a first circumferential groove along the equatorial plane and a second lateral circumferential groove, the second row
35 being located between the first circumferential groove and a third lateral circumferential groove, the said blocks being separated from each other by transverse

grooves having mid-line axes inclined with respect to the equatorial plane.

17. Tyre according to Claim 16, characterized in that the blocks of the two centre rows are staggered circumferentially with respect to each other.

18. Tyre according to Claim 16, characterized in that the mid-line axes of the transverse grooves of the two centre rows are inclined in opposite directions to each other with respect to the equatorial plane.

19. Tyre according to Claim 18, characterized in that the mid-line axes of the transverse grooves of the two centre rows are inclined in the same direction with respect to the equatorial plane.

20. Tyre according to Claim 16, characterized in that it comprises two rows of shoulder blocks at the sides of the centre rows, located in one case between the second circumferential groove and a first edge of the tread and in the other case between the third circumferential groove and the opposite edge of the tread, the blocks of the shoulder rows being separated circumferentially from each other by transverse grooves.

21. Tyre according to Claim 20, characterized in that the blocks of the two shoulder rows form mirror images of each other on each side of the equatorial plane.

22. Tyre according to Claim 20, characterized in that the blocks of one shoulder row, when rotated through 180° about the axial direction, match the blocks of the second shoulder row.

23. Tyre according to Claim 20, characterized in that each block of the shoulder rows is delimited by longitudinal sides which are parallel to the equatorial plane, by two transverse sides with curvilinear profiles and by a curvilinear linking profile between the axially inner longitudinal side and the rear transverse side.

24. Tyre according to Claim 20, characterized in that curvilinear profiles of the centre and shoulder blocks

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are arranged opposite each other along the second and third circumferential grooves, the said curvilinear profiles arranged opposite each other producing a widening of the circumferential groove intended to trap
5   snow.

25.   Tyre according to Claim 20, characterized in that the axial widths of the two rows of centre blocks are smaller than the axial widths of the two shoulder rows.

26.   Tyre according to Claim 16, characterized in that
10   the ratio between the axial width of the two centre rows and the width of the tread measured between the edges of the tread is not more than 0.45.

27.   Tyre according to Claim 20, characterized in that all the blocks of the centre and shoulder rows have
15   sipes.

28.   Tyre according to Claim 27, characterized in that the sipes of the centre blocks are parallel to each other.

29.   Tyre according to Claim 27, characterized in that
20   the sipes of the centre blocks are inclined in the opposite direction to the transverse sides of the blocks.

30.   Tyre according to Claim 27, characterized in that the sipes of the shoulder blocks are shaped in the form
25   of zigzags.

31.   Tyre according to Claim 27, characterized in that the sipes of the blocks of the centre and shoulder rows, the circumferential grooves between the rows and the transverse grooves of the rows essentially have the
30   same depth.

32.   Tyre according to Claim 27, characterized in that it comprises notches whose depth is in the range from 20% to 60% of the depth of the sipes.

33.   Tyre according to Claim 32, characterized in that
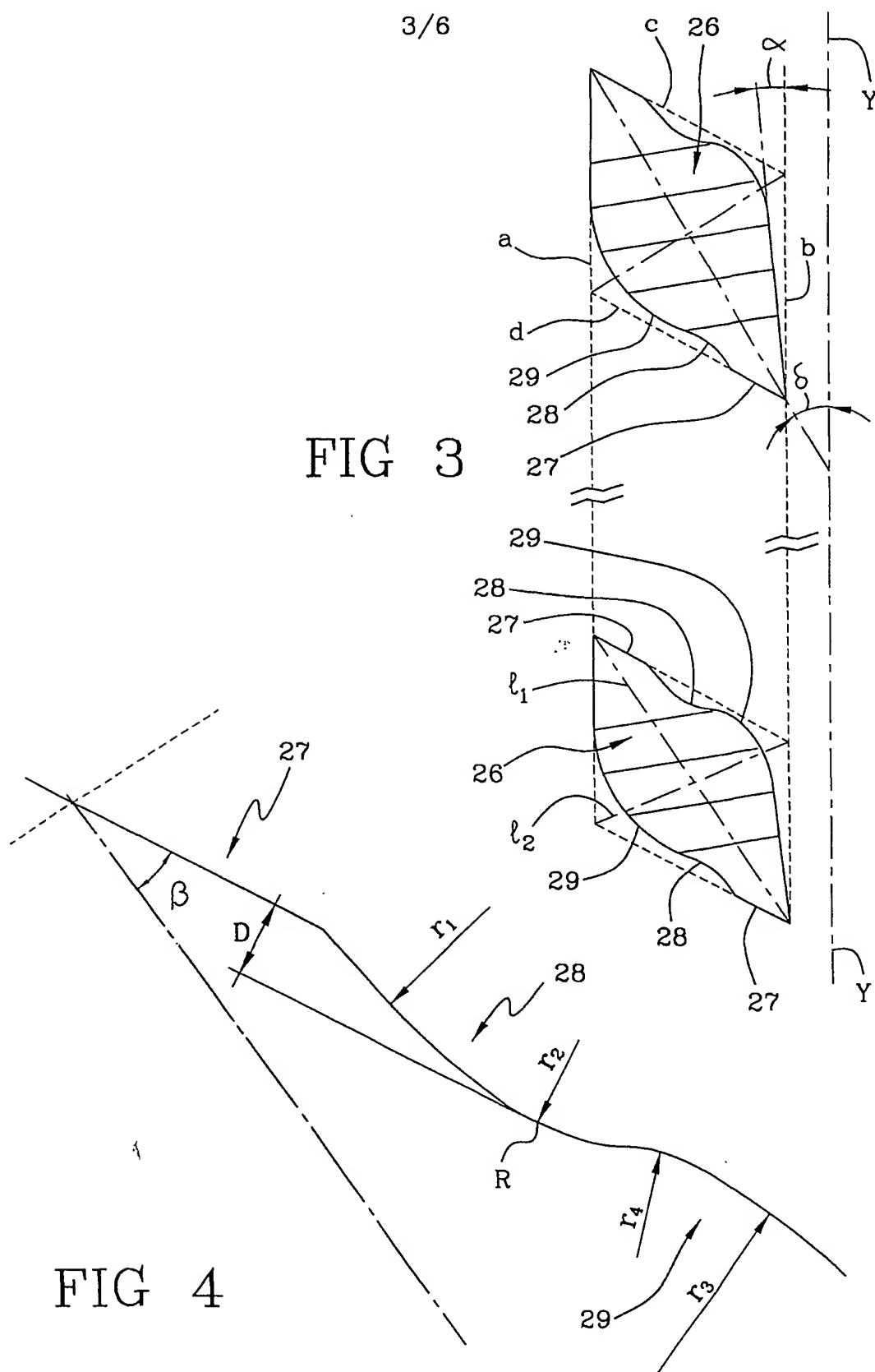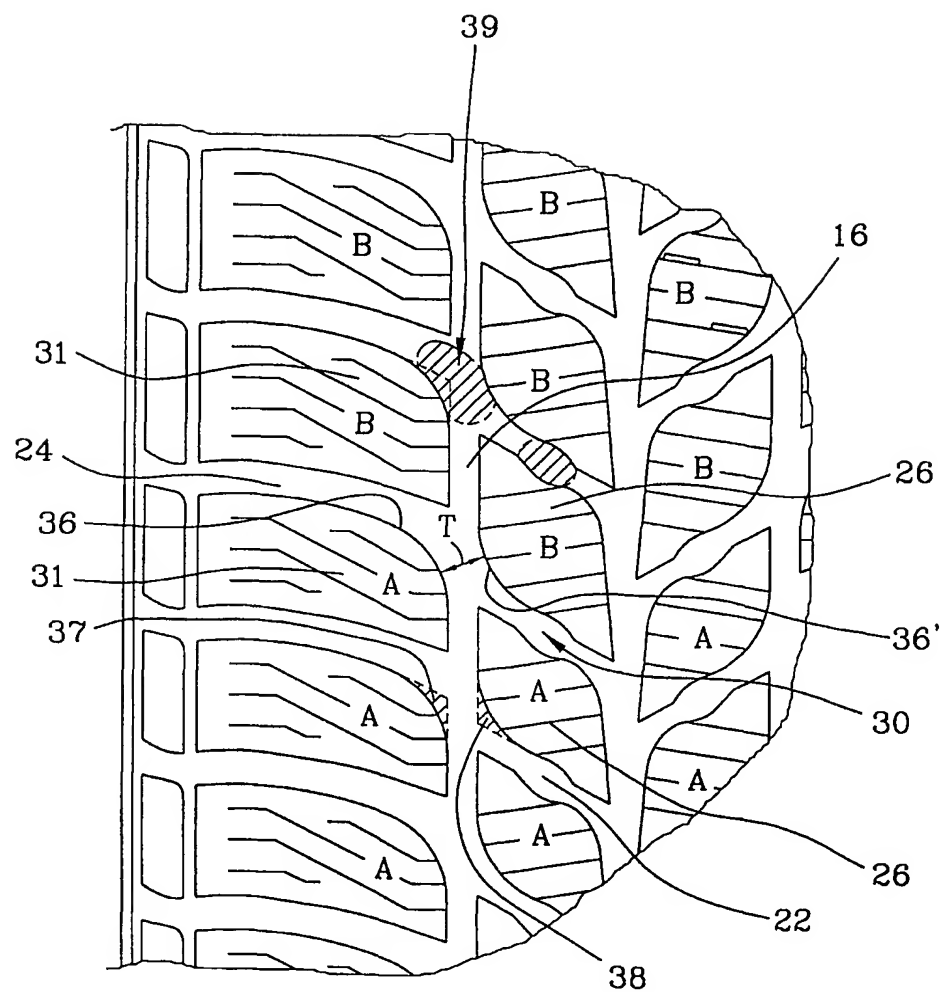35   the ratio between the depth of the notches and that of the sipes is 0.25.

FIG 1

FIG 2
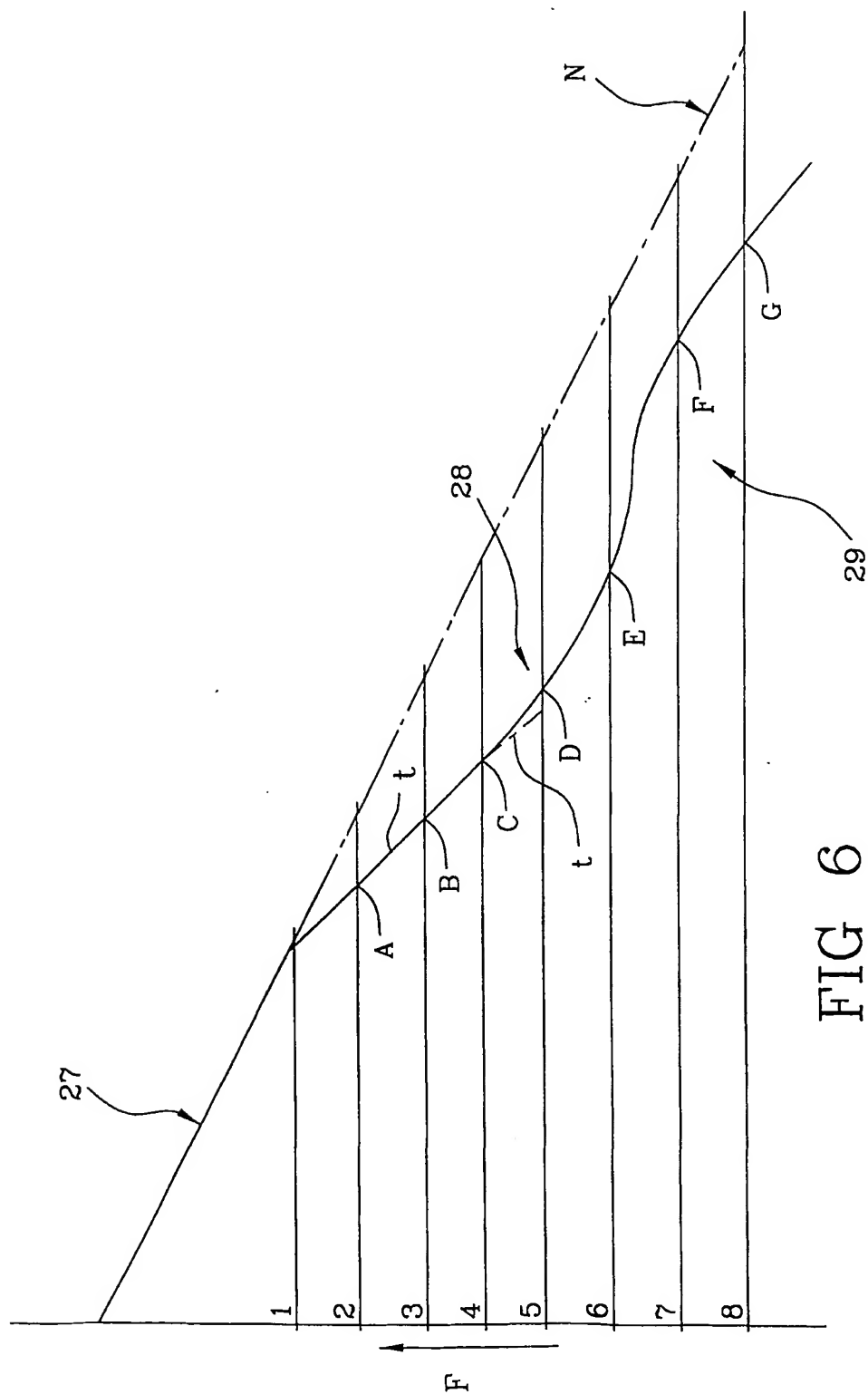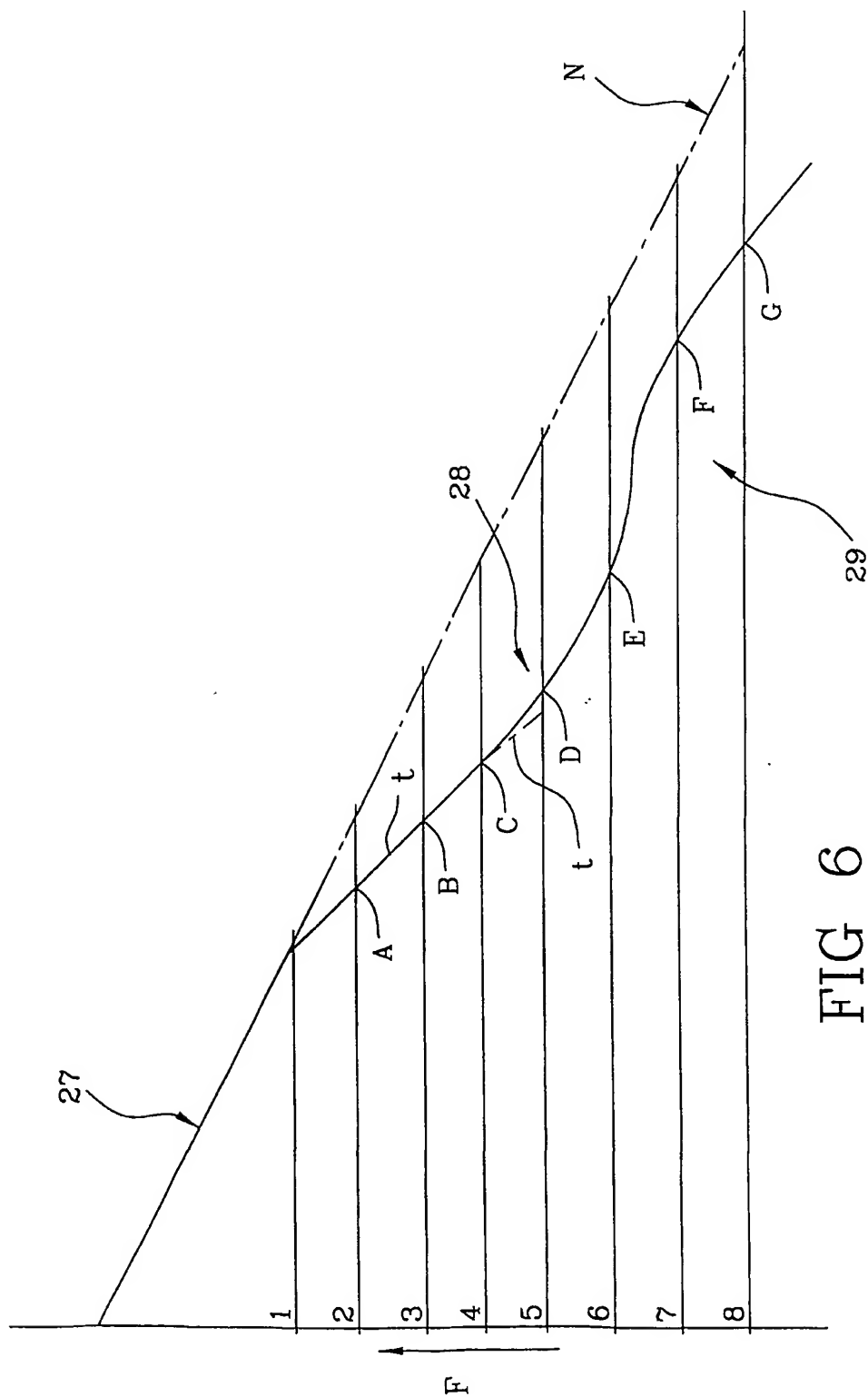
FIG 3

FIG 4

FIG 5

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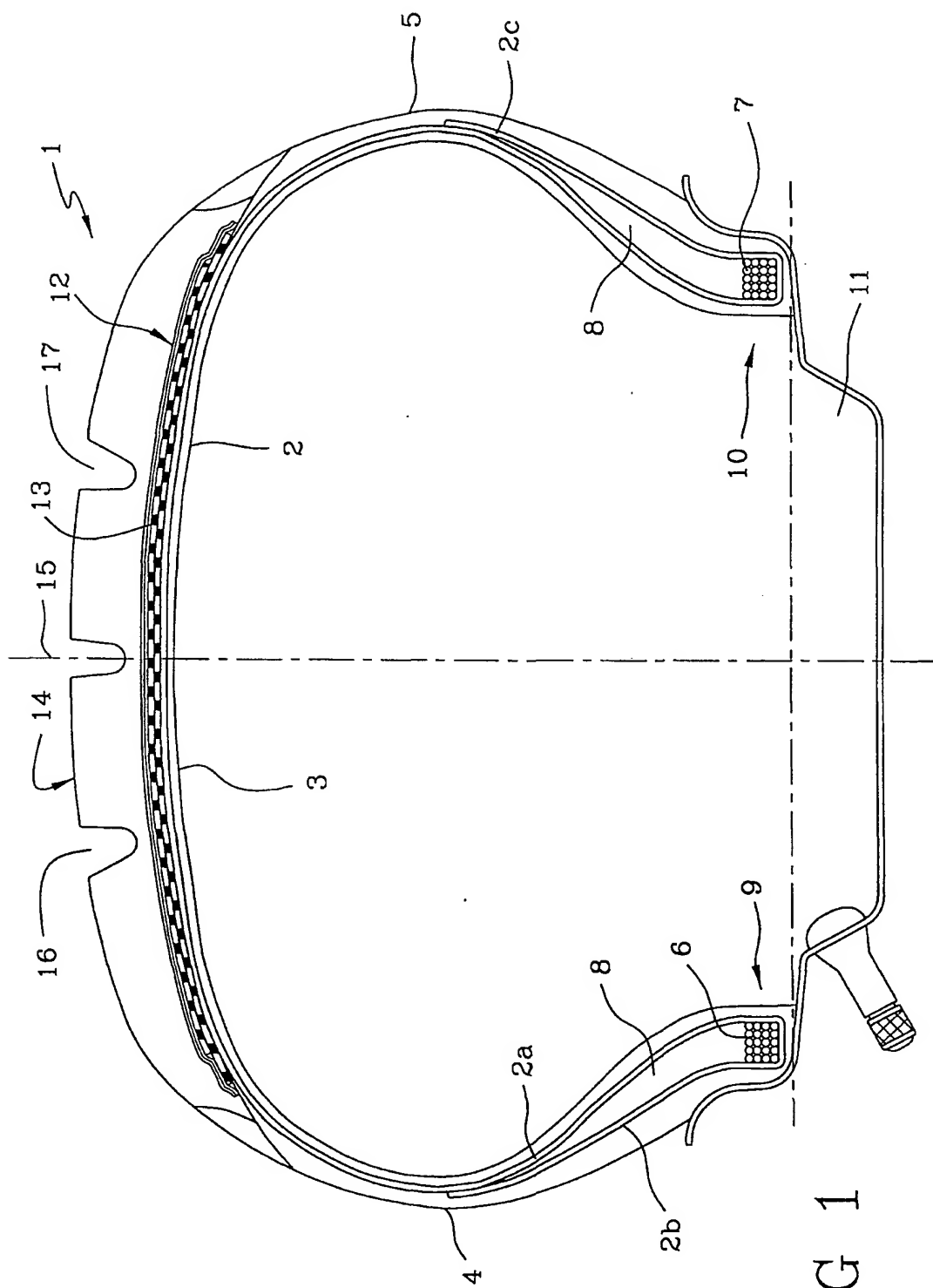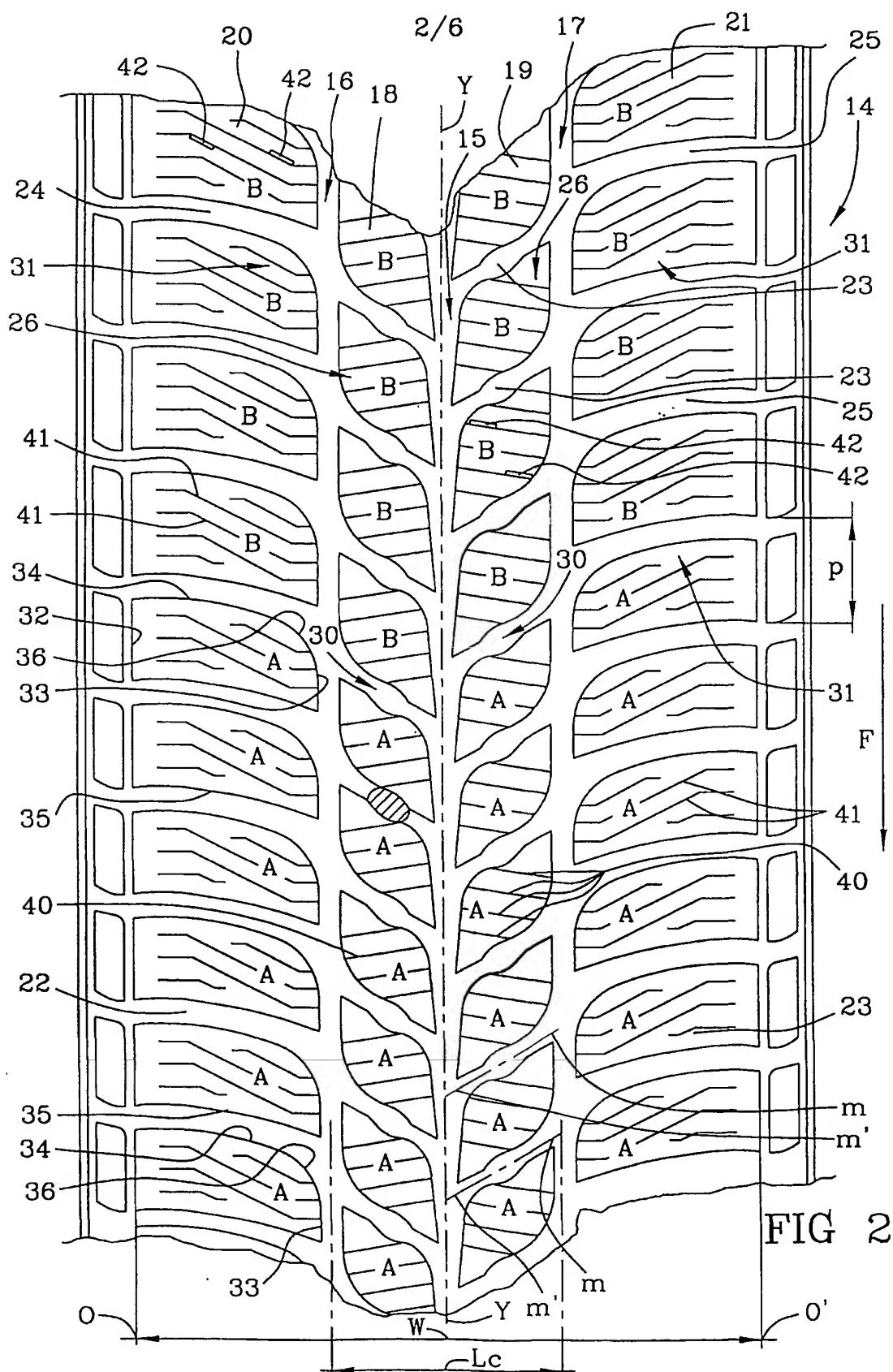
FIG 6

FIG 6

INTERNATIONAL SEARCH REPORT

International Application No

PCT/02/01692

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7   B60C11/11   B60C11/12   B60C11/03   //B60C107:00,B60C115:00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

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Y		12-18, 20,21, 25-31
Y	EP 0 485 883 A (GOODYEAR TIRE & RUBBER) 20 May 1992 (1992-05-20) column 3, line 18 –column 4, line 28 column 4, line 42 –column 5, line 32 figure 3	12-18, 20,21, 25-31

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| X | Further documents are listed in the continuation of box C. | X | Patent family members are listed in annex. |

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the International search	Date of mailing of the International search report
29 May 2002	27/06/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl. Fax: (+31–70) 340–3016	Peschel, W

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